

# Atmospheric Boundary Layer and Turbulence

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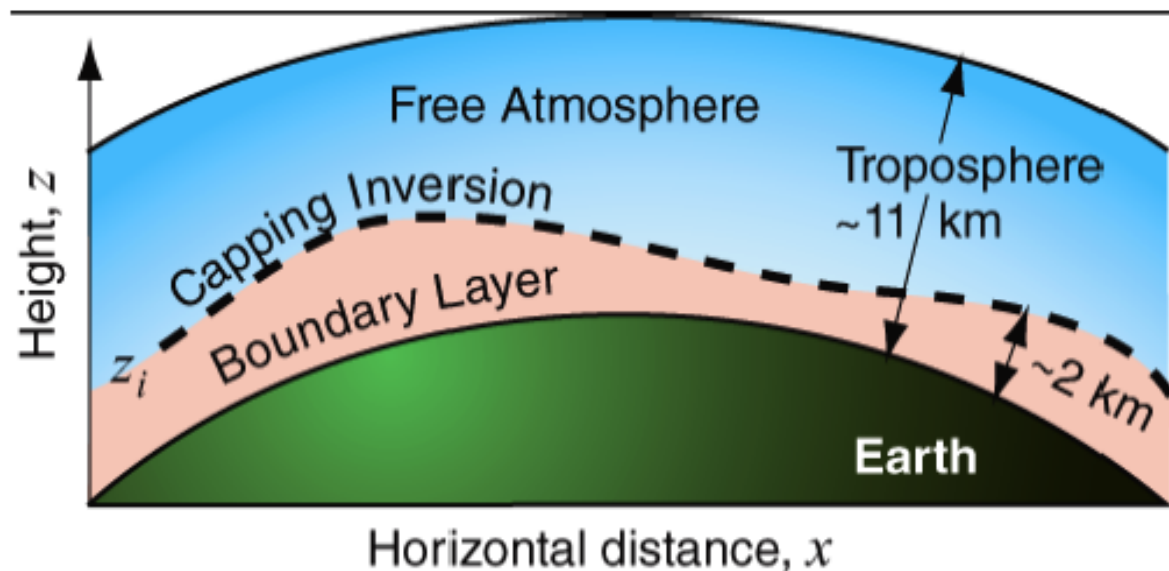
# ABL: Definition and Basic Properties

The layer of air **near the Earth's surface**, also called the Planetary Boundary Layer. It is that portion of the lower troposphere that feels the effects of the underlying surface within about 30 minutes or less. The surface influences ABL by friction and by heat fluxes at the surface.

This layer is **turbulent** and is well mixed. Turbulence is generated by wind shear (wind is approximately geostrophic at the top of the ABL but zero at the surface). Temperature gradients can either generate or suppress turbulence.

Temperatures vary **diurnally**, unlike the free atmosphere above. Its height evolves with time over the course of a day. Boundary layer clouds: fair-weather cumulus, stratocumulus, fog.

Maximum height: usually ~1 km, ~3 km over deserts, dry fields and boreal forests; 1–2 km over wetter surfaces.



# Why Study ABL?

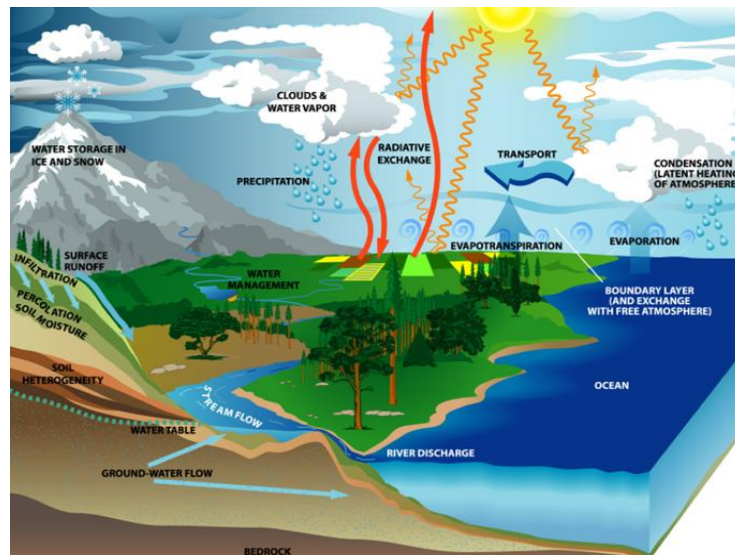
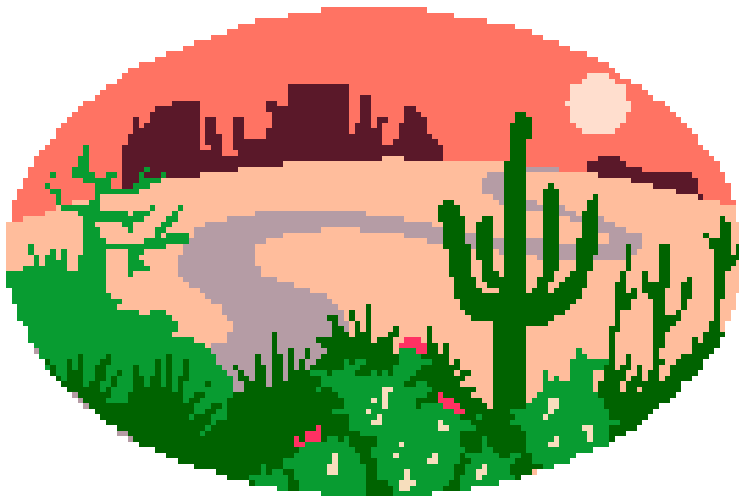
Humans live in the ABL.

Fluxes are mediated here. 50% of the atmosphere's kinetic energy is dissipated in the boundary layer.

It is the location of the source and sink of many trace gases (including water vapor, CO<sub>2</sub>, ozone, methane) and dusts/pollutants.

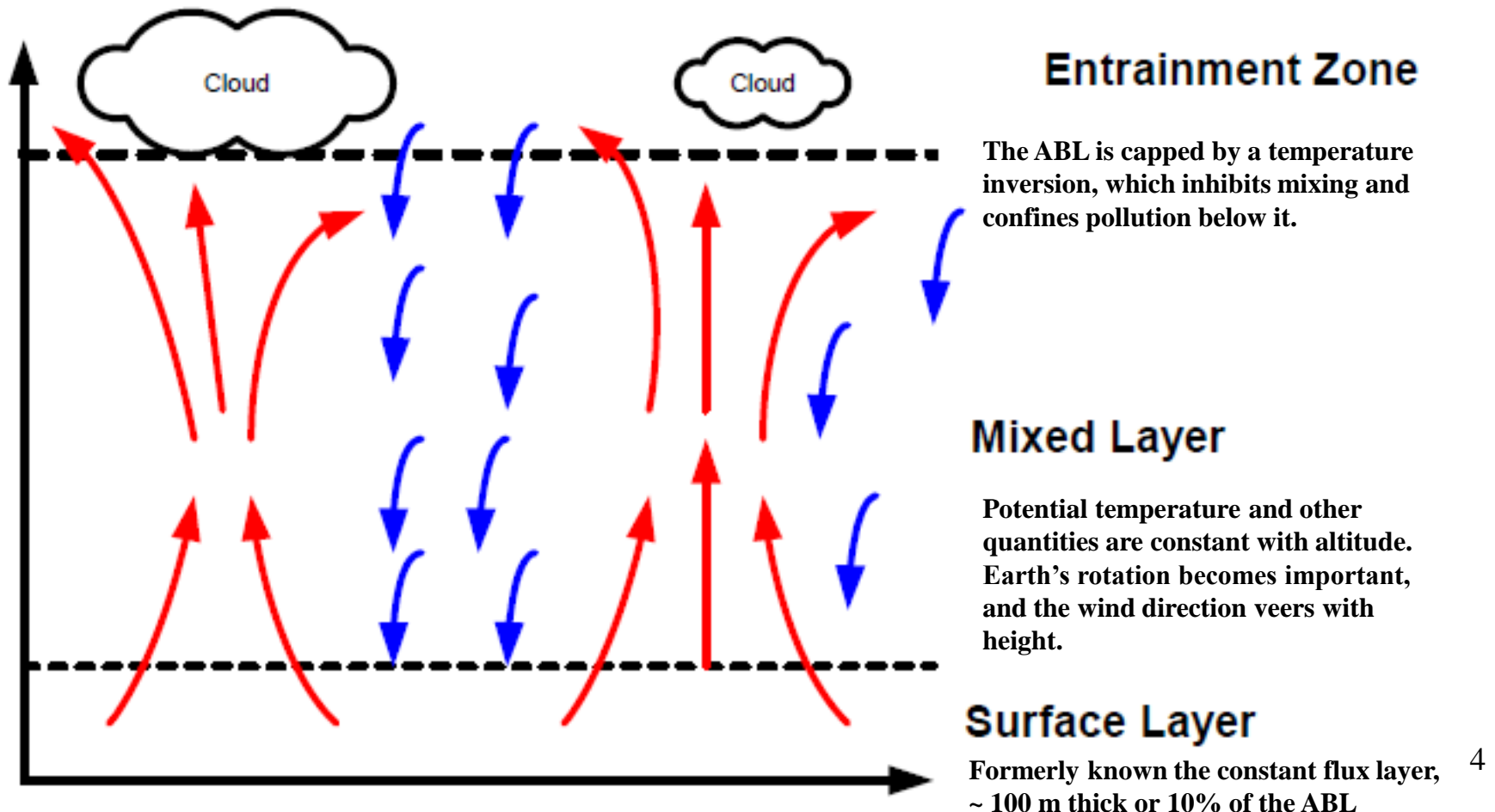
It is a reservoir of trace gases and pollutants.

It is important for local forecasting. There is a strong effect on the rest of the atmosphere. Boundary-layer clouds are very important for climate.

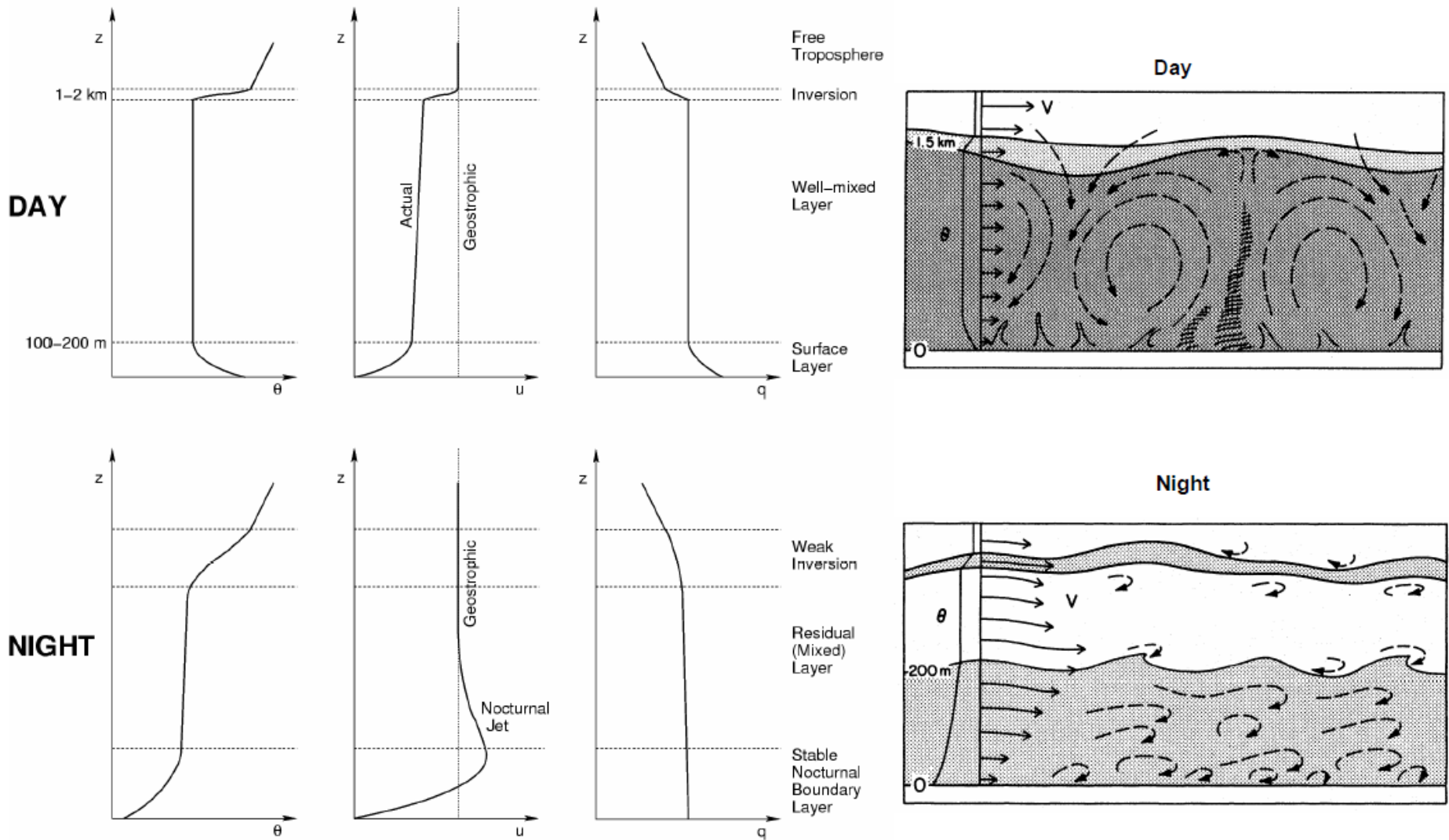


# Structure of ABL (1/2)

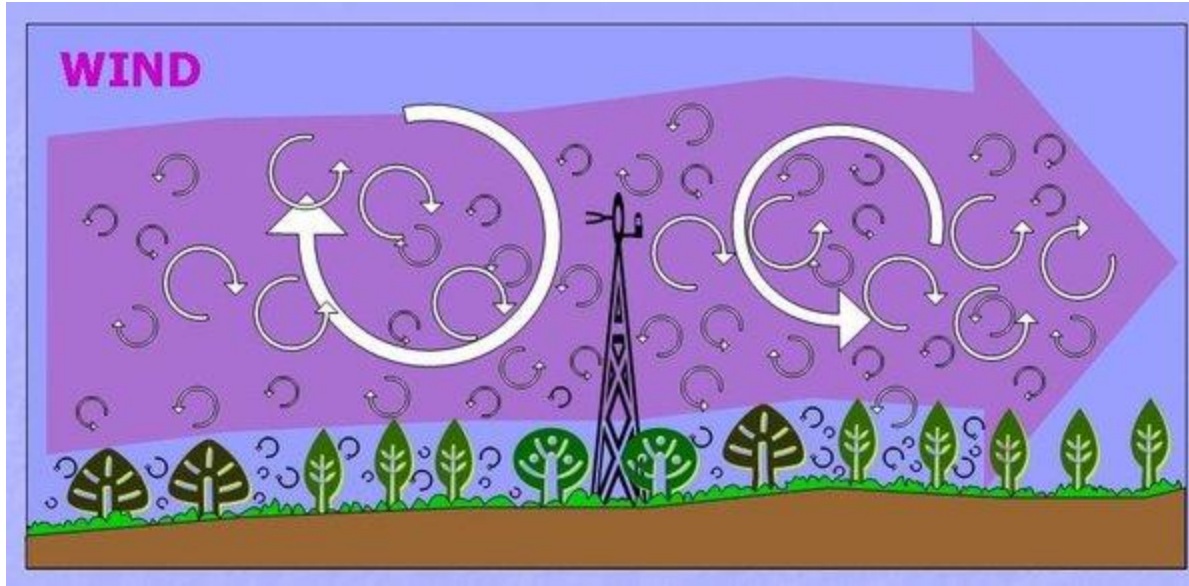
During a clear day, it consists of a **roughness sublayer** (air flows around individual roughness elements – grass, plants, trees, or buildings), a **surface boundary layer**, a **well-mixed layer** and a **capping entrainment layer**.



# Structure of ABL (2/2)



# Air Flow and Turbulent Vortices



Air flow can be imagined as a horizontal flow of numerous rotating eddies, a turbulent vortices of various sizes, with each eddy having 3D components, including vertical components as well. The situation looks chaotic, but vertical movement of the components can be measured from the tower.